

1 SPUR-TOOTHED WHEEL FOR A WORM GEAR AND A FORM FOR  
2 PRODUCING SUCH A SPUR-TOOTHED WHEEL

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B 4 Background of the Invention

5 The present invention concerns a spur-toothed wheel for a worm gear and a form  
6 for producing such a spur-toothed wheel by way of injection moulding, for  
7 example.

8  
9 Toothed wheels with helical gearing or globoidal or semi-globoidal toothed  
10 wheels are traditionally used as spur-toothed wheels for worm gears. While the  
11 tips of all teeth lie on a cylindrical surface in a simple toothed wheel having  
12 helical gearing, this surface in a globoidal toothed wheel has the shape of a  
13 concave circular arc in the axial profile. In a semi-globoidal toothed wheel, the  
14 cross section consists of a circular arc on which a straight line intercept touches it  
15 tangentially at the point closest to its axis.

16  
17 Globoidal or semi-globoidal toothed wheels are used in applications in which the  
18 tooth system must have a high load-carrying capacity, because a globoidal tooth  
19 system can support a worm having a diameter adapted to the circular arc of the  
20 globoid practically along the entire width of the tooth system, and not only in a  
21 center section, as is the case with a simple helical gearing. The production of  
22 globoidal wheels is much more laborious than that of simple helically-toothed  
23 wheels, however, because, in order to work a single globoidal tooth out of a  
24 toothed wheel blank or the blank of a form, the position of the tool must be  
25 continuously adapted according to a complicated scheme as the processing  
26 progresses.

27  
B 28 Summary of the Invention  
Advantages of the Invention

29  
30 As a result of the present invention, a spur-toothed wheel for a worm gear is  
31 created, on the one hand, which has a greatly improved load-carrying capacity as

1 compared to a traditional toothed wheel having helical gearing and a cylindrical  
2 circumferential surface, the production of which is markedly simpler and less  
3 expensive than that of a globoidal wheel, however.

4  
5 This is achieved in that, with a spur-toothed wheel for a worm gear which, in  
6 traditional fashion, has a first wheel disk having teeth on a cylindrical or conical  
7 face, at least one second wheel disk is added that touches the first wheel disk at  
8 a boundary surface and which carries teeth on a face designed in the shape of a  
9 truncated cone, whereby the teeth of the two wheel disks continuously mesh into  
10 each other at the boundary surface, and at least one of the two faces converges  
11 toward the boundary surface. In other words, one can conceive of designing the  
12 spur-toothed wheel according to the invention out of two wheel disks, of which at  
13 least one is designed in the shape of a truncated cone and the other is cylindrical  
14 or designed in the shape of a truncated cone, whereby at least one of the faces  
15 designed in the shape of a truncated cone is tapered toward the boundary  
16 surface. The constant meshing of the teeth of the two wheel disks is provided so  
17 that both wheel disks jointly mesh with the same worm and can thereby carry a  
18 load.

19  
20 Preferably, two second wheel disks are provided on both sides of the first wheel  
21 disk, so that the tooth system can carry a load at three places altogether.

22  
23 It is possible to produce each of the wheel disks individually and provide them  
24 with teeth and then combine the completed toothed wheel disks to form the spur-  
25 toothed wheel according to the invention. In this fashion, the spur-toothed wheel  
26 according to the invention can be produced out of metal using an abrading  
27 machining process, for example.

28  
29 It is preferred that the spur-toothed wheel be designed as a single piece. Such a  
30 spur-toothed wheel can be produced inexpensively using a moulding process  
31 such as injection moulding, out of a hard plastic, for example.

Object of the invention is therefore also a form for producing a spur-toothed wheel of the type described above which includes a tooth system insert for the simultaneous shaping of the teeth of all wheel disks.

Such a tooth system insert can comprise multiple formed wheels, each of which is complementary to one wheel disk. It is also possible in advantageous fashion, however, that the tooth system insert extend as a single piece across the entire axial width of the teeth of all wheel disks. Such a form is particularly easy to produce in that a number of processing steps corresponding to the number of wheel disks is carried out for each tooth notch using an abrading tool, whereby the tooth system insert has been tilted downward relative to the tool in the plane of the tooth notch between two processing steps.

The tooth system insert can be designed as a single piece in the circumferential direction. This makes it possible for a finished spur-toothed wheel to be removed from the mould using a helical motion. Such a form is suited to producing toothed wheels having two wheel disks, one of which is cylindrical.

As an alternative, the tooth system insert can be divided into multiple segments in the circumferential direction in order to make it possible to remove a finished toothed wheel from the mould by removing the segments in the radial direction.

Further features and advantages of the invention result from the following description of design examples with reference to the figures.

*Brief Description of the Drawings*  
A Figures

Figure 1 shows, highly diagrammed, two worm gears, one of which has a globoidal spur-toothed wheel, and the other of which has a helically-toothed spur-toothed wheel;

Figures 2 and 3 show an axial view of two variants of the spur-toothed wheel according to the invention;

Figure 4 shows two stages of the production of a tooth system insert;

Figure 5 shows the cross section of a tooth system insert according to a first design; and

Figure 6 shows a tooth system insert according to a second design, in top view and as a sectional drawing.

*Description of the Preferred Embodiments*  
~~Description of the Design Examples~~

In order to better illustrate the special nature of the present invention, Figure 1 first shows two traditional worm gears, a gear 1 having a globoidal spur-toothed wheel 2 and a gear 2 having a simple, helically-toothed spur-toothed wheel 4, both of them in mesh with a worm 5. In the idealized illustration of Figure 1, the worm 5 can be seen in both cases in a top view along its axis, and the spur-toothed wheels 3, 4 are shown as a sectional detail view.

In a helically-toothed spur-toothed wheel 4, contact between the spur-toothed wheel and the worm 5 is possible only on a narrow area 7 lying approximately in center on the tooth 6. The surface on which the spur-toothed wheel and the worm touch each other at a given point in time travels up and down within the contact area 7 in the course of the rotation of the gear on the tooth 6. In an idealized gear having absolutely stiff wheels, this surface would be punctiform, in practical application, its expansion depends on the flexibility of the material of the wheels and its extent of wear. The surface load of the contact area 7 is relatively great here, and it can lead to a rapid wearing of the spur-toothed wheel 4,

1 particularly if it is manufactured out of an inexpensive yet moderately resistant  
2 material such as a plastic.

3  
4 In a globoidal spur-toothed wheel 3, in contrast, contact with the worm 5 at all  
5 times is not possible at one point, but rather along a line that travels over the  
6 entire contact area 8 shown in the illustration as a shaded area in the course of  
7 the rotation of the gear. The contact area is practically identical with the surface  
8 of a tooth of the spur-toothed wheel. The load and, therefore, the wear, is  
9 distributed evenly across the entire surface of the tooth.

10  
11 Figure 2 shows a first design example of a spur-toothed wheel 11 according to  
12 the invention in an axial half-sectional view. The shape of the associated worm 5  
13 is indicated by dashed lines. The spur-toothed wheel 11 can be understood as  
14 comprising three wheel disks 12, 13, 14. The wheel disk 12 has a cylindrical  
15 circumferential surface, those of the wheel disks 13, 14 are designed in the  
16 shape of a truncated cone, whereby each smaller base area of the truncated  
17 cone forms a boundary surface with the wheel disk 12. All three circumferential  
18 surfaces have a helical gearing, whereby each of the teeth of the individual wheel  
19 disks continuously mesh into each other at the boundary surfaces 15. The groove  
20 angles of the circumferential surfaces designed in the shape of a truncated cone  
21 are specified as a function of the diameter of the worm 5 in such a way that each  
22 of the teeth of all three wheel disks touch those of the worm in contact areas 16,  
23 17, 18. The contact surface is therefore increased three-fold as compared with  
24 that of the worm gear 2.

25  
26 If an even greater contact area is required, the number of wheel disks and,  
27 therefore, the contact areas, can also be made larger than three.

28  
29 Figure 3 shows a simplified variant of the spur-toothed wheel from Figure 2. The  
30 wheel disk 13 designed in the shape of a truncated cone is eliminated in this

variant; instead, the cylindrical wheel disk 12 is widened. This variant is advantageous in production, as will become clear later.

Basically, the spur-toothed wheels shown in Figures 2 and 3 can be produced directly as globoidal wheels via abrading processing of a blank. A particular advantage compared to a globoidal wheel, however, is that the wheels according to the invention are suited for production via moulding and can therefore be produced much less expensively. In order to produce the teeth via moulding, a tooth system insert is required which can form a permanent or removable component of a form, of an injection moulding form, for instance. Figure 4 shows a diagram of the production of such a tooth system insert 20. A metal ring is used as the form for the production of the insert 20, the inner circumferential surface of which has multiple, sequential sections in the axial direction, each corresponding to the wheel disks of the toothed wheel to be produced. The ring 20 shown in Figure 4 has two such sections 21, 22, which correspond to the circular disks 12 and 14, respectively, of the spur-toothed wheel from Figure 3. In the production section illustrated in Part a of Figure 4, tooth notches 24 are created in the first section 21 using the electroerosion technique by way of a wire 23, each of which corresponds to teeth of the circular disk 12 of the toothed wheel to be produced. After the section 21 has been provided with tooth notches 24 all the way around in this fashion, the ring 20 is tilted downward relative to the wire 23, so that corresponding tooth notches can also be formed in the adjacent section 21 in extension of each of the tooth notches 24 of the section 21. This stage is illustrated in Part b of Figure 4. Every time a tooth notch 24 is completed on the section 21, the ring 20 can also be tilted, of course, in order to create the corresponding notch in the section 22. In this process, the orientation of the tilting axis and tilting angle is selected as a function of the dimensions of a worm in such a way that the teeth of both sections formed later by the tooth notches can mesh with the worm and carry a load.

Figure 5 shows the finished tooth system insert 20 installed in a shell 25 of an injection moulding form. The tooth system insert 20 can be permanently installed in the shell 25, since, in order to remove a toothed wheel produced therein from the mould, it suffices to rotate this around the axis 26 in order to cause the toothed wheel to detach from the form in an upward direction and come free.

If the tooth system insert for the production of a toothed wheel of the form shown in Figure 2 has two sections designed in the shape of a truncated cone as the section 22 from Figure 4, this simple method of removal from the mould is no longer possible.

Figure 6 shows such a tooth system insert 20' in a top view and as a sectional drawing. As one can easily imagine based on the sectional drawing, the second section 26 designed in the shape of a truncated cone prevents a finished toothed wheel from being screwed out of the insert in the axial direction. For this reason, the tooth system insert 20' is divided into multiple sectors 27 in the circumferential direction. The number of sectors can be greater than the four sectors shown in the figure; its number is specified as appropriate in such a way that a simple removal from the mould is possible by moving the sectors 27 off of the finished toothed wheel in the radial direction.